

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY, E. A. BIRGE, DIRECTOR; COLLEGE OF AGRICULTURE, UNIVERSITY OF WISCONSIN, H. L. RUSSELL, DEAN; A. R. WHITSON, IN CHARGE SOIL SURVEY.

SOIL SURVEY OF DOOR COUNTY, WISCONSIN.

BY

W. J. GEIB, IN CHARGE, AND CARL THOMPSON, OF THE U. S.
DEPARTMENT OF AGRICULTURE, AND H. V. GEIB, OF THE
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1916.]



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,

Washington, D. C., November 23, 1917.

SIR: Field Operations of the Bureau of Soils for 1916 included a soil survey of Door County, Wis., undertaken in cooperation with the Wisconsin Geological and Natural History Survey. The selection of Door County for survey was made after conference with State officials.

I have the honor to transmit herewith the manuscript and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1916, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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MAP.

Soil map, Door County sheet, Wisconsin.

SOIL SURVEY OF DOOR COUNTY WISCONSIN.

By W. J. GEIB, In Charge, and CARL THOMPSON, of the U. S. Department of Agriculture, and H. V. GEIB, of the Wisconsin Geological and Natural History Survey.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Door County is situated in the eastern part of Wisconsin, forming part of the peninsula which separates Green Bay from Lake Michigan proper. Washington Island, which forms part of the county, is separated from the mainland by Porte des Morts Passage, about 4 miles across at its narrowest point. Door County is bordered by Kewaunee County on the south. It is nearly cut in two by Sturgeon Bay; in fact, since the completion of the Sturgeon Bay ship canal the northern end of the peninsula is really an island. The peninsula is 18 miles wide at the base and gradually tapers to a width of about 4 miles. Its shores are very irregular, being indented by numerous bays and harbors. There are over 200 miles of shore line in the county. The distance from the extreme southwest corner of the county to Gills Rock, at the northern point of the peninsula, is nearly 60 miles. From Gills Rock to the northernmost point of Washington Island is 10 miles. The county comprises a total area of 469 square miles, or 300,160 acres.

The most prominent topographic feature in the county is the long line of rugged bluffs bordering Green Bay, extending almost unbroken from a short distance north of Sturgeon Bay to the northeast point of the peninsula. In some places the bluffs reach the water's edge; elsewhere they may be some distance back from the shore. Government Bluffs, on Sturgeon Bay in Nasewaupée Township; Eagle Bluff, at Ephraim; and the bluffs at Fish Creek and Ellison Bay are the highest and most striking in the county. They rise to elevations of 20 to 200 feet above the lake. From the top of these bluffs there is a gradual slope toward the eastern side of the penin-



FIG. 1.—Sketch map showing location of the Door County Area, Wisconsin.

sula, where a low narrow strip of Beach sand, or in places beach gravel, occurs. Just back of this beach are extensive areas of Peat. In the town of Claybanks high bluffs occur less than one-fourth mile back from the lake shore, in contrast to the conditions existing to the north of the Sturgeon Bay ship canal. The topography of the county in general is undulating to gently rolling, very little of the land being too rough for ordinary agricultural use. Some nearly level areas occur, principally in the swamps. Limestone escarpments and rock outcrops are quite abundant in that part of the county north of Sturgeon Bay. The surface here is typical of a glaciated region, with swamps and depressions scattered throughout the rolling upland. The southern part of the county is less rolling than that portion north of Sturgeon Bay, and marshes are smaller and more numerous than farther north, where most of the Peat occurs in a few large areas. A few small terraces occur on both shores of the peninsula. The topography of Washington Island is similar to that of the northern part of the county, varying from undulating to gently rolling. Chambers Island in Green Bay is nearly level, and is practically free from stone and rock. The elevation of the mainland of the county probably averages 100 to 150 feet above Lake Michigan, which lies 580 feet above sea level.

Door County has no large streams within its borders. The largest stream is the Ahnapee River, which flows south through Forestville and enters Lake Michigan at Algoma in Kewaunee County. That part of the county north of Sturgeon Bay has a few short streams, some of which are dry during a large part of the year. The southern part of the county is quite well ramified by small streams, some flowing into Green Bay and some into Lake Michigan, but owing to the heavy nature of the soil and subsoil drainage is in many places deficient.

Door County was formally opened for settlement in 1831. In 1835 the first white settler located on what is now called Little Sturgeon Point. The county was organized in 1851. In 1852 a colony of Moravians settled at Ephraim, in the northern end of the peninsula. In 1853 a colony of Belgians took up settlement at Brussels, in the southern part of the county. A settlement was very early made on Washington Island. In the northern end of the county, especially in the neighborhood of Ephraim, Bailey Harbor, and Ellison Bay, the population consists largely of Scandinavians. Quite a number of Germans and Poles live in the county. Other nationalities are also represented, some of the settlers coming from neighboring counties and some from other States. In 1910 the population of Door County was 18,711, all but 4,262 of which was classed as rural.

Sturgeon Bay, the county seat, with a population in 1910 of 4,262, is the largest town. It is surrounded by an excellent farming com-

munity. Sturgeon Bay is the center of a large cherry-growing section and a distributing center for the greater part of the county. Egg Harbor, Fish Creek, Ephraim, Sister Bay, Ellison Bay, Bailey Harbor, and Jacksonport are small coast towns north of Sturgeon Bay. Some of these towns, notably Fish Creek, Ephraim, and Sister Bay, are noted summer resorts, attracting thousands of tourists every year. The agreeable climate, the large bodies of water, the excellent roads, and the fine scenery combine to make Door County one of the most famous summer resorts in this section of the United States. Peninsular Park, the largest of the State parks, includes the whole peninsula between the villages of Fish Creek and Ephraim and covers about 6 square miles. Fishing is an important industry in the towns and bays along the coast. Many people depend on fishing for a livelihood, and at numerous points it is engaged in on a very large scale during the entire year. Washington Island is noted for its fisheries and summer resorts.

The Ahnapee & Western Railroad, which runs from Green Bay to Sturgeon Bay, is the only railway in the county. Two automobile stage lines carrying freight and passengers, one from Sturgeon Bay to Ellison Bay on the west side of the peninsula, and the other from Sturgeon Bay to Bailey Harbor on the east side, make daily trips in both directions. Lake steamers make regular stops at Sturgeon Bay, Egg Harbor, Fish Creek, Ephraim, and Washington Harbor during the summer season and at less frequent intervals during the spring and fall, giving direct communication with Milwaukee, Chicago, and other lake ports.

The main roads of Door County are as good as any in the State. On both sides of the peninsula there are excellent macadamized roads, one from Sturgeon Bay to Ellison Bay and the other from Sturgeon Bay to Bailey Harbor. In 1916 there were 125 miles of macadamized road in Door County, and the mileage has been extended since then. The abundance of limestone makes possible the construction of good roads at a comparatively low cost. In the heavy red clay section in the southern part of the county the roads which have not been macadamized are usually difficult to travel during rainy seasons and in the spring and late fall.

Rural mail-delivery routes reach practically every farm in the county. The stage from Sturgeon Bay brings mail to post offices in the northern part of the county, and from these stations rural routes reach all sections. Mail is delivered daily to Washington Island from Ellison Bay.

Sturgeon Bay furnishes a market for considerable farm products and provides a shipping point for fruit and other products. More fruit is shipped from Sturgeon Bay than from any other city in Wisconsin. Much of the farm produce is shipped by water.

CLIMATE.

The climate of Door County is milder on the Green Bay side of the peninsula than on the Lake Michigan side. The season begins sooner and the soil warms up earlier in the spring on the Green Bay side, and the average temperature is higher during the summer months, but frost occurs earlier in the fall than on the Lake Michigan side.

The average annual precipitation for Door County is a little over 31 inches. The greater part of the precipitation comes during the growing season, when most needed. During each of the six months from April to September, inclusive, the mean rainfall reaches 2.5 inches or more. There are times, however, during nearly every season when crops suffer from lack of moisture.

The mean temperature for the three winter months as recorded at Sturgeon Bay is 20.4° F. and for the months of June, July, and August, 63.9° F. The average date of the first killing frost in the fall as recorded at Sturgeon Bay for the seven-year period 1909 to 1915, inclusive, is October 2 and that of the last in the spring May 25, giving Door County an average growing season of 129 days. This is practically as long as the growing season at North Yakima, Wash., and Hamilton, Mont., the centers of two of the leading fruit districts of the West. Killing frost has been recorded at Sturgeon Bay as late in the spring as June 20, and as early in the fall as September 9. The growing season as recorded at Green Bay, in Brown County, about 15 miles south of the southern Door County line, is 23 days longer than that at Sturgeon Bay. The average date of the last killing frost in the spring here being May 3 and that of the first in the fall, October 3.

The favorable climate of Door County is the principal factor in making it such an important fruit growing district. The winters are milder than in regions farther south removed from lake influences, they are freer from prolonged cold snaps, and the snow which covers the ground almost continuously from December 1 to April 1 prevents deep freezing of the soil. There is an absence of the extremes in temperature which permit of alternate freezing and thawing in the winter. The cool waters of Lake Michigan and Green Bay cause late springs, which retard blossoming until the danger from frost is passed. The summers are cool and clear, with a comparatively uniform temperature from beginning to end, so that the fruit develops properly and produces good quality and color. In the fall the surrounding water, being warm from the summer's heat, prolongs the season and wards off early frost, enabling the fruit buds to develop properly and the new growth to mature.

In the following table are shown the normal monthly, seasonal, and annual temperature as recorded at Sturgeon Bay, and the normal

and extreme monthly, seasonal, and annual temperature and precipitation as recorded at Green Bay:

Temperature and precipitation at Sturgeon Bay and Green Bay.

Month.	Temperature.				Precipitation at Green Bay.		
	At Sturgeon Bay.	At Green Bay.					
	Mean.	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	° F.	° F.	° F.	° F.	Inches.	Inches.	Inches.
December.....	24.7	21.3	52	—21	1.81	1.78	0.99
January.....	18.7	14.6	51	—36	1.69	1.96	.91
February.....	17.9	17.2	59	—33	1.60	.74	.83
Winter.....	20.4	17.7	59	—36	5.10	4.48	2.73
March.....	26.6	26.8	82	—23	2.40	.41	.87
April.....	39.7	40.7	84	11	2.44	1.21	2.75
May.....	49.0	54.5	91	26	3.57	4.28	4.42
Spring.....	38.4	40.7	91	—23	8.41	5.90	8.04
June.....	60.4	65.1	100	34	3.55	2.37	8.68
July.....	65.7	69.5	100	43	3.51	1.44	4.95
August.....	65.7	67.0	98	40	3.10	3.71	5.26
Summer.....	63.9	67.2	100	34	10.16	7.52	18.89
September.....	59.5	59.1	95	25	3.12	1.24	4.86
October.....	47.6	47.1	84	8	2.37	.40	1.73
November.....	34.7	32.5	69	—12	1.96	1.50	1.78
Fall.....	47.3	46.2	95	—12	7.45	3.14	8.37
Year.....	42.6	43.0	100	—36	31.12	21.04	38.03

AGRICULTURE.

The first white settler in Door County located on Little Sturgeon Point in 1835. Agricultural development, however, did not begin until 1852-1855, when a settlement of Moravians was made at Ephraim and a large number of Belgians settled at Brussels, in the southern part of the county. The entire county was originally covered with a dense stand of timber, which was removed long ago. The early agriculture consisted mainly of grain production, with the growing of enough vegetables and fruit to supply the family. As was the case in nearly every other section of Wisconsin, wheat was at first the principal crop. Until about 1900 the wheat acreage was larger than that of any other cereal. From 1880 to 1900 over 200,000 bushels of wheat were produced annually. Wheat growing proved profitable for a long period, but gradually, owing to poor

cultivation, lack of fertilization, and continued cropping without any attempt to follow a systematic rotation, the soils produced such poor yields that some other line of farming had to be introduced. In 1909 only 3,474 acres of wheat were grown and 52,070 bushels produced, as compared with 16,616 acres seeded and a production of 239,000 bushels in 1899. Wheat production gradually gave way to a more diversified system of farming. Hay, oats, barley, rye, corn, and potatoes proved profitable crops, and dairying was begun. Fruit growing was taken up in place of wheat production. The principal field crops grown at present, named in order of acreage, are hay, oats, rye, barley, wheat, peas, potatoes, corn, flax, and buckwheat.

The total area devoted to tame hay in 1909 was 32,750 acres, from which 42,581 tons were obtained. About two-thirds of this consisted of clover and timothy mixed, about one-fifth of timothy alone, and one-tenth of clover alone. Very little alfalfa is grown, although over much of the county the soils are well adapted to this valuable legume. Only small quantities of marsh hay are cut. Most of the hay produced is fed to stock, but some farmers sell part of the crop each year.

Since the decline in wheat production, oats have been the leading small grain crop. In 1909 oats occupied 16,182 acres, on which 492,382 bushels were produced, or about 30 bushels per acre. The crop is well adapted to the soils of the county, and every farmer grows it. Some of the crop is sold, but the greater part is fed to stock on the farm.

Next to oats rye is the most important grain. In 1909 there were 8,468 acres in this crop, producing 130,260 bushels, or 15.4 bushels per acre. Barley is grown quite extensively. In 1909 a production of 128,166 bushels was obtained from 5,272 acres, the yield averaging about 25 bushels per acre. Considerable income is derived from the sale of barley, but part of the crop is fed on the farms. Wheat, while it has declined greatly in importance in the last 15 years, is still grown to some extent. In 1909 the crop was grown on 3,474 acres and produced 52,070 bushels, an average of 15 bushels per acre. Since that year, however, the growing of wheat has become less important.

Potatoes produce fairly good yields on most of the soils. The 1910 census shows a production of 225,391 bushels from 2,273 acres, an average yield of about 100 bushels per acre. Potatoes are grown mostly for home use.

Corn is not grown very extensively at present, but the acreage is being increased each year. In 1909 only 1,417 acres of corn were grown in the entire county, but since that year the growth of the dairy industry and the building of silos have led farmers to devote more land to the crop. The soils in that part of the county north of

Sturgeon Bay are better adapted to the growing of corn than is the heavy clay soil in the southern part. Corn does not always mature, but it never fails to reach the stage where it makes good silage. Certain early maturing varieties, recently produced through scientific selection and breeding, have been grown with much success.

The growing of peas for canning has developed into an important industry in the vicinity of Sturgeon Bay. Two large canning plants, one at Sturgeon Bay and the other at Sawyer, handle the peas grown on a large acreage. In 1913 the output from the cannery at Sturgeon Bay was 3,000,000 cans. Yields range from 2,000 to 2,200 pounds of shelled peas per acre. In sections too far removed from a cannery seed peas are grown. The yields average between 15 and 20 bushels per acre, and the crop sells for a very high price. Practically all the peas grown are contracted for, and the crop is handled by the factory owners. The factories employ a large number of men and use a great many mules and horses during the canning season. The crop is planted at intervals, so as to mature continuously throughout a month or more. Peas are not only a good money crop, but, when the vines are returned to the land, they improve the soil in the same manner as clover, and grain crops following peas give increased yields. The census reports a total of 21,845 acres devoted to peas in 1909, producing 307,739 bushels.

Trucking has been developed quite extensively in conjunction with fruit growing, especially in the vicinity of Sturgeon Bay. For several years while the fruit trees are growing and even after they have come into bearing there is considerable cultivable land between the rows of trees, and this is utilized for the growing of truck crops. Strawberries, blackberries, and dewberries are grown to a considerable extent, and vegetables are produced in quite large quantities. The 1910 census reports 101 acres in small fruits, of which strawberries alone occupied 72 acres.

Aside from fruit growing, dairying is the most important specialized industry. Dairy farming is developed most extensively in the southern part of the county on the heavy clay soils, but it is growing in importance each year even in the fruit districts. Quite a number of orchardists keep a dairy herd and find the combination of fruit growing and dairying very satisfactory, as it distributes the labor over the entire year and insures some income in case the fruit crop is a failure. The soils in the southern part of the county are very well adapted to dairying, as they produce good crops of hay and corn and supply good pasturage. The Kewaunee loam and clay loam are natural grass soils, producing heavy yields of hay and furnishing excellent pasturage. Perhaps the most thriving dairying community is the so-called Belgian settlement in the vicinity of Brussels. There are a number of fine pure-bred dairy herds in the county. Hol-

stein and Guernsey are the most popular breeds. Most of the dairy animals are of grade or scrub stock, but the type is rapidly being improved by the use of pure-bred sires. About 25 cheese factories and several creameries are operated in Door County. Most of the cheese factories are in the southern part of the county, but the section north of Sturgeon Bay is rapidly developing in dairying, and more cheese factories are being built each year. In 1909 there were 14,113 milch cows in the county producing dairy products valued at \$353,484.

The raising of beef cattle receives little attention in Door County, although there are numerous steep and rocky areas which are better suited for grazing than for general farming. Only a few farmers make a specialty of raising beef breeds, and most of the stock sold for slaughtering consists of mixed types. Many calves, the surplus of the dairies, are sold for veal. The horses throughout the county, notably in the Belgian settlement at Brussels, show more careful breeding than do the cattle. Heavy draft horses are common. Many colts are raised each year, and farmers frequently have a team to sell. In 1909 there were 7,405 sheep in the county. Sheep raising has never been important, but it will probably increase in the future. Hog raising is carried on in conjunction with dairying. Practically all the farmers produce enough pork for their own use and many have a considerable income from the sale of hogs.

The common crops are grown promiscuously on nearly all the soils of the county. The predominant soil in the southern part is the Kewaunee loam, while in the northern two-thirds the Miami loam predominates. On the heavy Kewaunee soils hay, corn, and small grains for feeding dairy cows are grown. These soils are well adapted to such crops. The soils in the southern part of the county are in general very well adapted to dairying, but not to fruit growing. The fruit industry is confined largely to the Miami loam, which is very well adapted to orcharding in both texture and topography. More attention has been given to soil adaptation in fruit growing than in connection with other crops.

Only a few farmers study the question of crop rotations and follow a fixed rotation from year to year. The same rotations are followed on nearly all the soils, regardless of their suitability. A rotation well suited to most of the soils consists of one or two years of small grain, with which grass seed is sown. Hay is cut for one or two years, after which the sod is plowed up and a cultivated crop like corn or potatoes planted. If desired the field may be pastured one year while it is in grass, thereby increasing the length of the rotation. On the Kewaunee soils it is advisable to keep the land in hay longer than on the Miami soils.

The methods of cultivation followed are not in all cases those best suited to the needs of the soil. This is especially true on the Ke-

waunee and Superior clay loams. Poor drainage keeps the soil wet until late in the spring, and in many cases the fields must be cultivated before the soil is dry enough to work up properly. This frequently leads to puddling of the soil, which requires considerable time and labor to correct. Fall plowing is done in most cases and gives good results, as the alternate freezing and thawing in the winter and spring breaks up the lumps and kills weed seeds and numerous insect and fungous pests. The stable manure produced is in general carefully preserved and put back on the land. The tendency is to cultivate the orchards with more care than the land used for other crops. On most of the larger orchards up-to-date machinery is used for cultivation.

Three noxious weeds are very abundant and troublesome in Door County. The Canada thistle is the most common. Many fields are completely overrun with this pest, and others are overrun with wild mustard. Quack grass is very troublesome in places. These weeds are quite difficult to eradicate, but they can be gotten rid of even where most abundant.¹

The farm buildings throughout the county as a rule are substantial and in good repair. On many of the dairy farms good silos are in use, and more are being built yearly. In the extremely stony sections stone fences are common. In the southern part of the county and in areas where stones are less numerous the fields are well fenced with barbed or woven wire.

The supply of hired help for the farms is usually insufficient, and outside the fruit-growing sections members of the family do most of the work except during extremely busy seasons. Farm laborers are usually paid \$30 to \$40 a month, with board. In the fruit sections large numbers of workers, including boys and girls of all ages, are brought in from outside cities during the picking season. They are paid by the amount of fruit picked.

The 1910 census reports 2,310 farms in Door County, with an average size of 109 acres. Over 84 per cent of the land in the county is in farms, and 53.4 per cent of this land is improved, giving each farm an average of 58 acres of improved land. Practically all the farms are operated by the owners. Only 3 per cent are leased to tenants, and less than 1 per cent are operated by a hired manager. It is the custom of the large orchard owners to engage skilled managers.

The price of farm lands depends largely upon the type of soil, the quantity of stone present, and the location. The highest-priced land in the county is in the fruit-growing section. In the northern end of the county, where most of the soil is shallow and stony, improved land can be purchased for \$50 to \$75 an acre. Farms on the Kewaunee loam not too far from the railroad are valued at \$100 or

¹ See Bul. Wis. Agr. Expt. Sta., Eradication of weeds.

more an acre. Farms on the sandy soils sell for \$20 to \$40 an acre. The 1910 census gives the average assessed value of land in Door County as \$37.90 an acre. Since that year, however, the average value has greatly increased. Cherry orchards in full bearing and in good condition sell for \$400 to \$500 an acre. Cherry trees produce their maximum yields when 10 to 20 years of age. Orchards which have not reached the full-bearing stage—that is, orchards about 5 or 6 years old, sell for \$300 to \$400 an acre, and young orchards about 2 years old for \$250 to \$300 an acre. These prices are the average for cherry orchards in the vicinity of Sturgeon Bay. In the northern end of the peninsula the selling price is about \$100 less an acre for each class of cherry orchards.

FRUIT GROWING.¹

Fruit growing in Door County really began in 1893 when 10 acres of plums were set out near Sturgeon Bay. In 1896, 3 acres of cherries were set out. During the next 10 or 15 years farmers in the vicinity of Sturgeon Bay and in other parts of the county made considerable plantings of cherries, apples, plums, and small fruit. Immense crops of excellent strawberries were produced. Until 1910 no very large plantings of cherries had been made, only a few orchards being more than 10 acres in extent. In the spring of 1910 one company set out 40 acres of cherries and 20 acres of apples. During the winter of 1911 many stock companies were organized, and in the spring thousands of cherry, apple, and plum trees were planted. One company alone set out 200 acres of cherry trees, which have since been increased to 700 acres. This is, as far as known, the largest orchard of sour cherries in the world. During 1912 and 1913 planting was carried on to an even greater extent, not only at Sturgeon Bay but also at many other points along the Green Bay side of the peninsula. At the present time the acreage in fruit is estimated at 3,500 acres of cherries, 1,700 acres of apples, and 200 acres of plums. Besides this a considerable acreage is devoted to strawberries, currants, raspberries, and other small fruits.

The Richmond and Montmorency are practically the only varieties of cherries grown. The apples grown most extensively on a commercial scale are the Wealthy, Oldenburg, Fameuse, McIntosh, Dudley, Northwestern, Tolman, and McMahon. Some other varieties have been tried. The chief varieties of plums grown are the Burbank, Lombard, Gueii, and Bradshaw.

Some grapes are produced in different parts of the county. The varieties grown are Campbell, Moore, and Norton.

¹ For more detailed information on the planting and management of orchards, see Buls. No. 201, 207, 269, Wis. Agr. Expt. Sta.

Door County is so well adapted to the growing of fruit, especially cherries, largely on account of its favorable climate and soils. The Miami loam, on which most of the fruit is grown, is a mellow loam soil ranging from 1 to about 4 feet in depth, overlying limestone rock. Cherry trees have a peculiar ability to take root and flourish on very shallow soil, and in numerous cases trees planted in soil so shallow that holes had to be blasted in the rock have made splendid growth and produced heavy yields. The roots penetrate the seams and crevices and apparently obtain moisture and plant food from the very rock. The rolling topography induces good drainage, without which cherry trees can not grow well.

The climate of Door County is extremely well adapted to fruit growing. The waters of Lake Michigan and Green Bay delay the occurrence of frosts in the fall, permitting the fruit to ripen, the buds to develop, and the new growth to mature while the foliage is still on the tree. In the spring the cold winds from these waters retard blossoming until danger from frost is past. The summers are cool, with comparatively little change in temperature from day to night, also a condition favoring the proper development of the fruit. On the Green Bay side of the peninsula the season is on the average about two weeks earlier than on the Lake Michigan side, owing to the fact that the waters of Green Bay warm up quicker in the spring than the waters of Lake Michigan. Cherries and other fruits grown on the Green Bay side of the county ripen and can be put on the market two weeks earlier than fruit grown on the lake side. For this reason cherry growing is confined largely to the west side of the peninsula. In the fall, however, killing frosts occur earlier on the Green Bay side, owing to the fact that the lake cools more slowly.

The principal problem which confronts the cherry grower is to get the labor to care for the orchard and to pick the fruit. An orchard to be profitable requires careful plowing and cultivating and regular spraying, and the fruit must be picked as soon as it ripens. On the average it takes five good pickers per acre for a mature orchard in a good season. Some of the larger orchard owners bring in a large number of pickers from Milwaukee, Chicago, and other cities each season. The pickers are housed in buildings or tents erected on the grounds. For the last few years a summer Y. M. C. A. camp has been maintained at Sturgeon Bay during the cherry-picking season. This camp furnishes a large number of pickers. In the immediate vicinity of Sturgeon Bay children and other persons out of employment are engaged to pick cherries. The farther the fruit grower is from Sturgeon Bay the more difficult it is to obtain competent help. Each season more and more pickers will be needed, as only a small proportion of the trees planted have reached maturity. Since the

spring of 1913 no extensive plantings have been made except the replacing of trees that have grown too old or have died. The average life of a cherry tree is about 20 years. Even if no more trees are set out it is probable that the present acreage is all that can be cared for when the trees mature. All the trees now growing will not reach maturity, as some orchards are planted on soil unfit for cherry culture, where the subsoil may be too heavy, the topography too level, and the drainage deficient. Some orchards have been greatly injured or even ruined by improper care or poor methods of cultivation. Spraying, which yearly becomes more important with increase in fungous diseases and insect pests, is sometimes neglected.

The first step toward solving the problem of marketing cherries and other fruits so as to obtain the highest prices was taken in 1910, with the organization of the Door County Fruit Growers' Exchange. This organization sells all the fruit collectively and does away with local competition. The business is handled by a manager elected by the board of directors. The highest market prices are received and the results obtained are much more satisfactory than before organized marketing existed. Most of the cherries are marketed in Minneapolis, St. Paul, Duluth, and other cities of the Northwest.

In the future the acreage devoted to apples will undoubtedly increase. Apples are not nearly so perishable as cherries, they do not require so many pickers per acre, and are not necessarily marketed immediately after being gathered, as is the case with cherries. The life of an apple tree is considerably longer than that of a cherry tree. Door County is situated near good markets, such as Chicago, Milwaukee, and the Twin Cities, and can successfully compete with western apples.

Clean, thorough cultivation is essential in cherry growing. The orchards are cultivated at regular intervals until about the 10th of July. In young orchards a cover crop is sown in the late summer or early fall. This serves as a protection during the winter and when plowed under in the spring it increases the supply of organic matter in the soil. In young orchards various cultivated crops are sometimes grown between the rows of trees. The soil would require thorough cultivation even if no crops were grown and this use of the land gives the owner a source of income before the orchard comes into bearing. Potatoes, beans, and strawberries are the crops usually grown in orchards. In old orchards no cover crop is ordinarily grown, weeds being allowed to grow up after cultivation is over for the season. Mature orchards are not plowed each year as are the young orchards, but are first worked with a disk harrow and cultivated during the season with some other harrow or cultivator. Most of the growers practice hoeing around the trees where the harrow

can not be used. This not only kills the weeds but also covers up the old, fallen leaves in which are harbored fungous and other diseases.

Up to the present time the only fertilizer used in cherry growing has been stable manure. Best results have been obtained by applying manure yearly around the trees to cover an area somewhat larger than the spreading branches. With young trees just coming into bearing there is danger of manuring too heavily, as heavy applications of fertilizer high in nitrogen may produce tree growth instead of fruit. It is probable that commercial fertilizers will have to be resorted to before long.

Spraying is recognized as a necessity in orcharding. To be effective, spraying must be done thoroughly at the proper time, and with the proper materials. The three most common cherry pests are the shot-hole fungus, the brown rot, and the black aphid. The most common pests of the apple are the codling moth, aphid, scab, curculio, oyster-shell scale, and fire blight. No particular program of spraying can be followed from year to year. Some of the pests, like the shot-hole fungus of the cherry, are not as yet sufficiently understood. The care and management of apple and plum trees is practically the same as that for cherry trees, except that the time of spraying and the kind of spray materials vary, with difference in the fungous and insect pests.

SOILS.

Door County, in common with all northern and eastern Wisconsin, owes the general character of its surface materials to glaciation. Three more or less distinct periods of glaciation have existed, but the Late Wisconsin drift is the surface formation over practically all the county. The bedrock, which is frequently exposed, is the Niagara limestone. The soils are all derived from glacial or lacustrine material, or both. In the southern part of the county lake-laid material has been deposited, probably during interglacial times. Its most characteristic feature is the occurrence of heavy red clay in the subsoil and frequently in the surface soil. Since its deposition this material has been more or less modified by the moving ice sheet, which changed the topography from nearly level to rolling and very materially altered the texture of the surface soil.

The underlying limestone has entered largely into the formation of the glacial surface covering, but the occurrence of granitic boulders and other rocks foreign to the region indicates that the soil material has come in part at least from distant areas. While the entire county was undoubtedly covered by ice during the Late

Wisconsin glaciation, some of the soil has strong indications of being of residual origin. This is true of the shallow soils of the Miami series. It is probable that the glacier in passing scraped all the soil from some of the highest land, and after receding left areas of bare rock exposed. Since then various agencies have changed the exposed rock to soil, giving rise to some of the shallow soil occurring in different parts of the peninsula.

Since the glacial period, numerous changes in the surface material have taken place. Stream action, weathering, accumulation of organic matter, and other processes have been important factors in changing soils to their present condition. Soils of 7 separate series with 4 miscellaneous types, have been mapped in Door County. The Miami series includes the light-colored, timbered upland soils derived from glaciated limestone material. The soils of glacial-lake origin are classed in the Kewaunee, Superior, Poygan, and Clyde series, and those occupying outwash plains or terraces in the Fox and Plainfield series.

The Miami is the most extensive series in Door County. The Miami soils are light brown to brown, with a lighter colored subsoil which grows somewhat heavier with increased depth. As a rule these soils are quite shallow and stony, and contain numerous outcrops of the underlying limestone. They are derived from the weathering of glacial material of a generally calcareous nature. The topography is undulating to rolling, and the natural drainage is excellent.

The Kewaunee series is developed in Wisconsin in the regions bordering Lake Michigan and Lake Superior and in the Lake Winnebago region. It is characterized by grayish to reddish-brown or red surface soils, underlain by red or pinkish-red, heavy clay subsoils. The soil material is essentially like that of the Superior series, and the greater part of it was laid down originally as glacial-lake deposits, but it has been plowed up by subsequent glaciation and mixed with varying quantities of gravel and stony material. The topography varies from gently rolling to rolling, and the natural surface drainage is good, though the underdrainage is often deficient.

The surface soils of the Superior series are brown or reddish brown to red, with pinkish or red clay subsoils. This series comprises a group of glacial-lake soils similar to the Kewaunee series in all respects except topography. The surface is level to very gently undulating, resulting in very deficient drainage.

The surface soils of the Poygan series are dark brown to black. The subsoil is a heavy red clay, similar to that of the Superior soils. The series is closely associated with the Superior and has the same

origin, except that it occupies low, wet depressions in which the decay of a luxuriant growth of vegetation has resulted in a black color of the surface soil.

The soils of the Clyde series are dark brown to black, overlying gray, brown, or yellowish subsoils. The Clyde soils have been formed in lakes, ponds, or other low, swampy areas along streams or on the borders of swamps, and are confined to glaciated limestone regions. Through the influence of poor drainage and the accumulation of decayed vegetation the surface soils are black and very high in organic matter.

The Fox series consists of light-brown to brown surface soils and yellowish-brown subsoils. In topography, location, and origin the series is similar to the Plainfield, but it differs in being derived largely from limestone material. It occurs on outwash plains, in filled-in valleys, or on terraces along streams or lake shores. Occurring in a limestone region and containing considerable limestone these soils are ordinarily not acid, or only slightly so.

The Plainfield series includes light-brown soils with yellow subsoils. The material has been derived largely from sandstone and deposited on stream or lake terraces, in filled-in valleys, or as glacial outwash. The surface is level or gently undulating, and the subsoil is stratified. The series is confined chiefly to noncalcareous glaciated regions, but is encountered also in unglaciated sections of the United States in filled-in valleys and on stream terraces, and also in limestone regions where through excessive leaching all the lime carbonate has been removed and the soil is acid. The lighter types predominate in this series, and the soils tend to be leachy and droughty.

Peat includes low, wet areas of partially decomposed plant remains, containing varying amounts of mineral matter. Muck includes low, wet soils high in organic matter, intermediate between Peat and the soils of the Clyde series.

Beach sand consists of material which has been washed up on the shore by the waves. Much of it, especially the areas of fine sand, has been blown by the wind to such an extent as to produce a broken surface.

Rough stony land includes steep, rocky slopes, extensive rock outcrops, extremely stony areas, and land otherwise unfit for cultivation, and valuable only for the small amount of timber and grazing it supplies.

In the following pages of this report the various soils of Door County are described in detail and discussed in their relation to agriculture. The distribution of the soils is shown on the accompanying map, and the table following gives the name and the actual and relative extent of each type.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami loam.....	94,720	31.5	Miami fine sand.....	4,800	1.6
Kewaunee loam.....	53,760	17.9	Poygan loam.....	3,584	1.2
Peat.....	41,408	13.8	Superior clay loam.....	3,008	1.0
Miami fine sandy loam.....	30,528	10.2	Plainfield sand.....	1,984	.7
Kewaunee clay loam.....	17,600	5.9	Muck.....	1,792	.6
Beach sand.....	8,192	2.7	Clyde silt loam.....	1,536	.5
Miami silt loam.....	7,680	2.6	Kewaunee fine sandy loam....	1,344	.4
Miami gravelly loam.....	7,616	2.5	Plainfield fine sand.....	1,152	.4
Miami gravelly sandy loam....	6,784	2.3	Fox silt loam.....	768	.3
Clyde loam.....	6,208	2.1			
Rough stony land.....	5,696	1.8	Total.....	300,160

MIAMI GRAVELLY SANDY LOAM.

The Miami gravelly sandy loam is a somewhat variable type, but the greater part of it is either typical or included in a variation which is characterized by a level to undulating surface. The typical soil which has a rolling topography consists of a loose, light-brown sandy loam to an average depth of about 8 inches. Gravel and boulders in varying quantities and sizes occur on the surface and through the soil. The subsoil is a reddish-brown, gravelly sandy loam. The gravel content increases with depth, and the subsoil in places is a bed of pure gravel. The undulating areas have a typical surface soil, but the soil here is shallow. It occurs on the points projecting into Lake Michigan and near the shore on the east side of the peninsula. Boulders and outcrops of limestone are common, and the bedrock occurs at depths varying from 1 to 3 feet.

The Miami gravelly sandy loam is not an extensive or important type. It occurs, however, in all but the southern part of the county, occupying small areas associated with other types of the Miami series. Some rather large areas occur on Washington Island.

The typical Miami gravelly sandy loam has been derived from glacial material, and occurs in the form of eskers, drumlins, and moraines. The undulating variation also has been derived from the weathering of glaciated material, but this was not left in morainic form as in the case of the typical soil. The topography of the typical areas is rolling to broken and bumpy, consisting to a considerable extent of hills, knolls, and long, narrow ridges. The drainage is thorough and rapid. The gravelly nature makes the soil rather droughty, but in seasons of sufficient rainfall fair yields are produced.

A considerable proportion of this type is under cultivation. Some of it is still in forest. The original timber growth consisted chiefly

of oak, pine, maple, and some other hardwoods. The same general farm crops are grown as on the Miami loam, but yields average lower than on the heavier Miami types. About the same rotations are followed. Fertilization is confined to the application of barnyard manure.

This soil is low in organic matter, which should be added by plowing under green crops, preferably the legumes. The steeper slopes should be used for hay production or pastured, so as to prevent erosion. Alfalfa should do well in the deep, rolling areas, as the gravelly subsoil results in ideal drainage conditions. The more level, shallow areas are very subject to drought and require careful management to produce good yields.

MIAMI GRAVELLY LOAM.

The surface soil of the Miami gravelly loam consists of a friable, brown loam, which extends to an average depth of 8 inches. There is a large amount of gravel on the surface and through the soil. Much of the gravel is angular, and frequently the particles are quite large. The surface soil grades into a light-brown or yellow gravelly fine sandy loam. The content of gravel increases with depth, and it is usually impossible to penetrate the deep subsoil on account of the gravel. This type is not very extensive, but numerous areas varying in size from a few acres to one-half section or more are scattered over that part of the county north of Sturgeon Bay, associated with other types of the Miami series. This is one of the most rolling soils in the county; in fact, the rolling topography is one of its most characteristic features. It occurs on drumlins or eskers or in areas of choppy or broken land in the morainic sections. The rolling topography and gravelly subsoil make the type droughty. Erosion is active in periods of heavy rains.

Agriculturally this is not a very important type, although a considerable proportion of it is cleared and some of it is cultivated. The original timber growth was the same as on the other Miami soils. The same crops are grown as on the other Miami types, and the yields obtained are about the same. The type is farmed under similar methods of cultivation. Much of it is probably better suited to use as pasture land than to general farming, although even some of the most rolling areas are under cultivation.

MIAMI FINE SAND.

The Miami fine sand consists of a yellowish-brown fine sand, 6 to 10 inches deep, underlain by a pale-yellow fine sand which becomes a little coarser with depth. The soil is loose and open and very low in organic matter. When the surface is bare it is sometimes blown by the wind. Numerous small areas of this type are scattered

throughout the county from Washington Island to the region of heavy red clay in Brussels Township. The surface is gently rolling to rolling, and owing to this and to the loose, open character of the sand crops suffer from drought except when the rainfall is heavy and well distributed. This soil has been farmed with varying degrees of success. Much of the type is still uncleared, although the original timber has long since been removed. This consisted largely of pine and of oak, with varying proportions of other hardwoods.

In wet seasons when the rainfall is well distributed good yields of common farm crops are obtained. Potatoes, corn, rye, oats, buckwheat, and truck crops give the best results. Some cherry orchards have been planted on this soil, but they have either made a very poor growth or died out entirely.

The Miami fine sand is easily plowed and cultivated. It becomes dry and warm very quickly, and can be worked earlier in the spring than the heavier soils and under a much wider range of moisture conditions. On the other hand, it is low in water-holding capacity and subject to wind erosion. To obtain the best yields heavy applications of manure must be made and green crops plowed under at regular intervals. Commercial fertilizer could be applied to advantage on this soil. In the vicinity of Sturgeon Bay and other markets trucking could profitably be extended.

A few widely scattered areas of coarser sand are included on the map with the Miami fine sand. It is similar in origin, topography, and all other features except texture. The surface soil of the sand type to an average depth of 8 inches consists of a yellowish-brown sand of medium texture. It is loose and open in structure, and low in organic matter. The subsoil is a pale-yellow sand which becomes a little coarser with increased depth. Most of this type is still uncleared, although the original timber has long been removed. This consisted chiefly of pine and oak, with scattered balsam and hardwoods other than oak. The soil has the same agricultural adaptation as the typical Miami fine sand, and it should be handled in the same way in order to obtain profitable yields.

MIAMI FINE SANDY LOAM.

The surface soil of the Miami fine sandy loam consists of a friable, brown to grayish-brown fine sandy loam, about 8 inches deep. In some areas gravel occurs on the surface and in the soil mass, while in other places the texture may approach that of a sandy loam. The line separating this type from the Miami loam could not everywhere be sharply drawn. Boulders in considerable numbers were originally found upon the surface, and rock outcrops are quite common. The subsoil to within about 2 inches of the bedrock is composed of a

yellow light-brown fine sandy loam. In some places the material in the lower depths is quite sandy, but directly overlying the rock there is a thin layer of darker colored, sticky loam which carries scattered fragments of partially decomposed limestone.

There are only slight variations in this type. The depth to bedrock varies considerably, although it is usually less than 3 feet. On the highest hills and in the most rolling areas there is usually a considerable depth of glacial débris above the bedrock. In sections 9, 16, 20, 21, and 29, Claybanks town, the subsoil is heavier and the depth to the underlying limestone much greater than typical. In places the deep subsoil is a red clay, and in some of the road cuts this clay appears at depths varying from 3 to 7 feet.

The Miami fine sandy loam is quite widely distributed throughout the county, chiefly north of Sturgeon Bay, where it occurs in association with other soils of the Miami series. It is most extensively developed in the towns of Sevastopol and Liberty Grove. More than one-third of Washington Island is occupied by this soil.

The surface of the type varies from undulating to quite rolling. Occasionally it occupies long ridges. On account of the surface relief and the sandy texture the drainage is excellent. In the most sandy areas it is excessive and the soil tends to be droughty.

The Miami fine sandy loam has been derived from the weathering of glacial drift which occurs chiefly in the form of ground moraine, although there are a few kames and drumlins included in the type. Ground-up material from the underlying limestone has entered largely into the composition of the soil, although the presence of granitic boulders shows that at least a portion of the drift must have come from farther north.

The Miami fine sandy loam is an important type agriculturally. Probably over 60 per cent of it is under cultivation, the remainder being in woodlots or used for permanent pasture. The original forest growth consisted chiefly of maple, birch, balsam, basswood, white pine, and different varieties of oak. The common farm crops are grown on this soil. The average yields are not as large as on the heavier Miami soils. Potatoes, corn, rye, and truck crops are best adapted to this soil. Cherries and other fruits do not produce as well as on the Miami loam. There are some fairly good cherry orchards on the Miami fine sandy loam, but it can not be considered a good fruit soil in this county.

MIAMI LOAM.

The surface 6 to 8 inches of the Miami loam consists of a yellowish-brown to grayish-brown loam. The subsoil consists of a yellowish-brown loam or fine sandy loam grading into a thin layer of compact,

reddish loam which contains fragments of partially decomposed limestone. This heavy layer rests upon the bedrock, which typically occurs within 3 feet of the surface. The type grades into a fine sandy loam on one hand and into a silt loam on the other, but so gradually that a sharp boundary can not always be drawn. As this was originally a forest region the soil is somewhat deficient in organic matter. In virgin areas there are numerous bowlders and fragments of limestone. The stoniness is quite a serious handicap in farming, especially in the northern end of the peninsula where the soil is particularly shallow and bowlders numerous. In some small areas where the soil is extremely shallow angular limestone gravel occurs. These areas are indicated on the map by symbol.

The type is quite uniform in texture, although it does include small areas in which the surface soil is either too light or too heavy to be typical, and others in which the subsoil is too heavy to be typical. The most important variation is in the depth to the underlying rock, which varies from 1 to 3 feet. Areas in which the soil is less than 1 foot deep, as well as those in which it is more than 3 feet deep, are indicated on the map by symbol. The typical Miami loam has a depth of soil of 1 to 3 feet.

The Miami loam is the most important and extensive type in the county. It occupies a large proportion of the county for some distance north of Sturgeon Bay, occurring in association with other types of the Miami series. The topography is undulating to gently rolling. In some sections large plateaulike elevations rise to a considerable height above the surrounding land. A large orchard north of Sturgeon Bay is located on such a plateau. In places there are very pronounced steep slopes or escarpments. Beginning several miles north of Sturgeon Bay there occur rugged limestone cliffs ranging in height from 20 to over 100 feet. These are confined largely to the Green Bay side and to the north end of the peninsula. Owing to the undulating topography, the natural drainage is good except in a few small depressions.

The Miami loam has been derived from glacial material which has undergone considerable weathering. The drift contains considerable limestone material, but bowlders of other kinds of rock also are intermixed with the soil. It is probable that most of the soil was originally ground by the glacier from the underlying limestone. The native vegetation on this type consists chiefly of oak, maple, basswood, elm, balsam, and white pine. In many unimproved areas a second growth of poplar has sprung up. About 60 per cent of the Miami loam is under cultivation. Aside from fruit growing, which is a very important industry on this soil, general farming is the most important type of agriculture. Until a few years ago the tendency was to go more and more extensively into fruit growing, but within

the last year or two dairying is becoming more important. The principal crops produced are oats, barley, rye, peas, hay, and corn. Corn does not always mature before the first killing frost in the fall, but it always makes sufficient growth to produce good silage. In the vicinity of Sturgeon Bay, where a pea cannery is operated, a considerable acreage is devoted to the growing of peas for canning. The most important fruit grown is the cherry. Apples, plums, currants, grapes, strawberries, and other small fruits and berries are also grown on a commercial scale.

This soil is not hard to handle. The drainage is nearly always thorough, and the soil is sufficiently loose and mellow to make tillage easy. Where the soil is shallow, that is, only slightly over 1 foot deep, crops soon suffer in dry periods. The type is almost invariably plowed in the fall except in the case of orchards, which are usually plowed in the spring. Stable manure is the only fertilizer used for general farm crops. Where cherries or other fruits are grown there is a tendency to apply much of the manure to the orchard, at the expense of the other crops.

The selling price of land of the typical Miami loam is quite variable, depending upon the location and development. In the vicinity of Sturgeon Bay the price is high, but in the northern end of the county near Ephraim and Ellison Bay improved land can be purchased for \$40 to \$60 an acre. Thrifty cherry or apple orchards which have come into bearing sell for \$400 to \$600 an acre.

In improving this soil perhaps the foremost need is to increase the organic-matter content. This can be done most satisfactorily by growing legumes, such as clover, and plowing a crop under every three or four years. The type naturally is not as productive as the deeper soils, and it needs the incorporation of more plant food. Phosphate fertilizer could be applied to this soil to advantage. The growing of alfalfa could be profitably extended.

There are included with the Miami loam on the map and indicated by means of symbols, isolated areas which differ only in their extreme stoniness. The surface 8 inches consist of a friable, brown loam, which is underlain by a lighter colored loam or sandy loam. The depth to bedrock is variable, but is usually less than 3 feet. Boulders, large and small, are scattered over the surface. Excepting the Rough stony land, it is the most stony soil in the county. It is of very small extent and of little importance. Small areas are scattered throughout the northern part of the county in association with the other Miami soils. Only a small proportion of the land is cleared, and this is used almost wholly for pasture, as the stoniness practically prohibits cultivation. This soil is not included with the Rough stony land because of the possibility that the stones may even-

tually be removed and the land placed under cultivation, while the Rough stony land apparently will always be nonagricultural.

Areas of the Miami loam in which the underlying limestone rock is more than 3 feet below the surface are distinguished on the map from the typical soil by means of symbols. The surface soil to an average depth of 8 inches consists of a rather heavy, brown loam. With a few exceptions it is practically free from gravel, and stones are not as numerous as in the typical areas. The subsoil consists of a yellowish-brown loam which usually becomes slightly heavier with depth. In some areas, which are indicated on the map by symbols, the subsoil is so heavy and sticky that the drainage is very deficient. The deep areas of Miami loam occur largely in the towns of Sturgeon Bay and Sevastopol. Smaller areas are scattered through the county. The surface varies from gently undulating to undulating, with some small nearly level areas in hollows or other depressions. In places where the heavy subsoil occurs, and where the drainage is deficient unless the slope is quite steep, cherry trees do not thrive as well as on the shallower soils where the heavy subsoil is lacking, and in several instances cherry orchards have died. The soil retains moisture well, and crops suffer less during long dry spells than on most of the other soils of the county. The deep areas of Miami loam are productive, and probably over 80 per cent of the soil is under cultivation. The remainder is still in forests or is used as pasture. The original timber growth was the same as on the typical soil. Some of the finest and oldest cherry orchards in the county are located on the deep areas of Miami loam. Where the subsoil is not too heavy cherries do better than on any other soil. Farm crops of all kinds produce good yields. Oats, barley, rye, potatoes, corn, and hay are grown extensively. Clover and alfalfa do well and are increasing in acreage each year. Dairying is becoming quite an important industry, a considerable number of pure-bred dairy herds being kept. In general, the same methods of farming are followed as on the typical soil. The drainage is not as thorough in all places, however, and tile drains could profitably be installed.

A shallow variation of the Miami loam is also distinguished on the map. It consists of a brown, friable loam, which remains unchanged until just above the bedrock, where a thin, compact layer of loam or clay loam occurs. This lower layer contains numerous fragments of partially decomposed limestone, and angular limestone pebbles often occur on the surface and through the soil. Bedrock is invariably reached at depths of 3 to 12 inches below the surface. Stones are quite numerous, in many places seriously retarding cultivation. Rock outcrops are more numerous than in the areas of typical Miami loam. The shallow variation is a rather unimportant soil. It occurs in small areas in various parts of the county, associated

with the other types of the Miami series. The surface is mainly undulating to gently rolling, but there are small plateaulike areas where the surface is nearly level. While this soil occurs in the glaciated region, it is probably in part of residual origin. In passing, the glacier scraped the rock free from soil and left no deposit. The weathering of the rock has produced the thin mantle of soil. The angular gravel, stones, and fragments of the bedrock mixed with the soil indicate that it is largely of residual origin. A smaller proportion of this shallow soil is under cultivation than of the typical Miami loam. Some of it is used for pasture and some is still forested, the timber consisting chiefly of oak, maple, balsam, and pine. Cherry trees are grown with considerable success on this shallow soil, as the roots enter cracks and crevices in the rocks. The same methods of farming, fertilization, and crop rotation are followed as on the typical Miami loam.

The following table gives the results of the mechanical analyses of samples of the soil and subsoil of the Miami loam:

Mechanical analyses of Miami loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
312503.....	Soil.....	1.4	4.1	5.4	28.2	17.5	34.2	9.0
312504.....	Subsoil.....	1.6	4.2	5.8	33.3	19.8	25.9	9.6

MIAMI SILT LOAM.

The surface soil of the Miami silt loam consists of a brown mellow silt loam extending to an average depth of 8 inches. The content of fine sand is quite high, and when dry the soil has a loamy appearance. The subsoil is a light-brown or grayish silt loam, usually quite compact and sticky, in the lower depths. The heavy subsoil is characteristic of this type. Most of the type is more than 3 feet deep. Directly above the bedrock there is a heavy, reddish layer which contains numerous small fragments of limestone. There are usually a few limestone pebbles in the subsoil, and in places stones occur on the surface.

This soil is quite uniform. The most important variation is in the depth to bedrock, which varies from 1 to more than 3 feet. In very few places is the bedrock within 1 foot of the surface. Some rock outcrops occur, but the type is not as stony as the Miami loam and fine sandy loam.

The Miami silt loam is not very extensive. It occurs largely in the town of Sevastopol. Small areas are scattered over the northern part of the county. The surface varies, as in the Miami loam, from gently undulating to rolling. This type is not as rolling and in some

places, as in sec. 21 and the NW. $\frac{1}{4}$ of sec. 22, T. 28 N., R. 26 E., and in the immediate vicinity of Institute, there are some nearly level areas. In the rolling sections the surface drainage is excellent, but in the more level areas where a heavy subsoil occurs the underdrainage, and even the surface drainage, is quite commonly deficient.

The Miami silt loam is derived from glacial *débris* laid down mostly in the form of a ground moraine. The surface soil, which is quite silty, may have been deposited in part by winds. The gravel and stones are largely limestone, and it is probable that limestone from the bedrock has entered largely into the formation of the type. The subsoil does not show an acid reaction, but the surface material has been leached to such an extent that a slightly acid condition has developed in places.

The original forest growth on this type consisted of maple, basswood, elm, balsam, birch, white pine, and different varieties of oak. All the valuable timber has been removed, and approximately 60 per cent of the type is now under cultivation. Part of it is still uncleared and used as woodlots or for permanent pasture.

This is a very valuable type agriculturally. The chief line of farming carried on is dairying. All the common farm crops are grown and produce good yields. Corn, small grains, and grasses are well adapted to this soil. Some cherries and apples are grown, and good results are obtained where the surface is sufficiently rolling and the subsoil is not so heavy as to prevent good drainage. Some cherry orchards set out on level areas with the heavy subsoil have made poor growth or died.

This type is somewhat harder to work than the other Miami soils and requires more thorough cultivation to maintain a proper physical condition. On account of its heavy subsoil, it remains wet until late in the spring. Stable manure is the only fertilizer used, and where cherries are grown the greater part of this is applied to the orchard. The rotation commonly followed consists of corn, a small grain for 2 years, and timothy or clover. This soil seems best suited to dairying and the growing of general farm crops. Its supply of organic matter can be increased by supplementing the stable manure with green-manure crops. In the level areas with heavy subsoil tile drains could be profitably installed.

Except for areas of the types occupied by cherry orchards this is the highest priced soil in the county. As much as \$100 to \$150 an acre has been paid, even for farms located a considerable distance from Sturgeon Bay.

KEWAUNEE FINE SANDY LOAM.

The upper 8 inches of the Kewaunee fine sandy loam consists of brown fine sandy loam. This is underlain by a lighter colored fine

sandy loam to fine sand which extends to an average depth of about 30 inches. The deep subsoil consists of a heavy, red clay which extends to the bedrock. Some gravelly material occurs in the soil and subsoil, and boulders are scattered over the surface in places. In a number of places the surface soil is lighter in texture than typical. In the town of Claybanks just back of the strip of lowland along the lake shore much of the material classified as Miami fine sandy loam is like the Kewaunee series in the presence of a red clay substratum, but the depth to this stratum is so great as to have little influence on the soil and it therefore is mapped with the Miami series.

The Kewaunee fine sandy loam is one of the less important types of the county. Its total extent is only about 2 square miles. The largest area occurs in sections 27 and 28 in the town of Union. Smaller areas occur near the bay shore, in sections 30 and 31, Sevastopol Town.

The type has a gently rolling to rolling surface. In section 30, Sevastopol Town, it occurs on a long, high hill, with a few rock outcrops on the slope. The type has good natural drainage, and on account of the clay subsoil it retains moisture very well, except possibly in the area in Sevastopol Town, where the rock is close to the surface.

Like the other members of the Kewaunee series, this soil is partly lacustrine and partly glacial in origin. The surface soil is in most places acid, owing to the leaching of the material originating from limestone, and consequent loss of lime carbonate. The native timber growth was quite similar to that on the other Kewaunee types, except that white pine was more abundant.

Agriculturally, the Kewaunee fine sandy loam is not very important. Much of it is still unimproved. The area north of Sturgeon Bay is largely forested and has an unfavorable topography. The soil is easy to cultivate and produces good yields of the ordinary farm crops. It is low in organic matter, which should be supplied by applying stable manure and turning under green manure crops, of which clover is the best. Ground limestone or burnt lime could be profitably applied in nearly all cases, and a phosphate fertilizer would prove beneficial.

The selling price of improved land of this type varies from \$50 to \$75 an acre.

KEWAUNEE LOAM.

The surface soil of the Kewaunee loam consists of a grayish-brown loam varying in depth from 10 to 20 inches. It contains some angular gravel and fragments of limestone in places, boulders are abundant on the surface in some areas, and here and there the bed-

rock outcrops. As in the case of the other timbered upland soils, the supply of organic matter is low. The subsoil consists of a brownish-red to chocolate-colored clay loam which contains sufficient sand and other coarse material to give it a gritty feel. The gravel, rock fragments, and bowlders consist largely of limestone, but some rocks foreign to the region are encountered. The depth to the limestone bedrock varies, but is more than 3 feet in most places. The subsoil of this type in Door County is somewhat different from that of the typical Kewaunee loam as it occurs on the shores of Lake Superior. It contains much more coarse material and therefore lacks the smooth, plastic feel of the typical subsoil. Glacial action is doubtless responsible for the modification.

The texture of this soil type is very uniform. The principal variations are in the depth of the underlying rock and in the quantity of stones on the surface. In the northern part of Nasewaunpee Town, in much of Gardner Town, and in sections 3 and 4 of Brussels Town, the depth of bedrock is less than usual, being in many places less than 3 feet. Rock outcrops and stones are more numerous here than in the typical areas. In the immediate vicinity of outcrops and where stones are numerous, both which conditions are shown on the map by symbols, the soil is usually shallow.

The Kewaunee loam is the most extensive and important type in southern Door County. Aside from one small area in section 5 of Sturgeon Bay Town and another in section 7 in the town of Sevastopol it is confined to the region south of Sturgeon Bay. It is closely associated with the Kewaunee clay loam, and it is often very difficult to separate sharply from that type.

The surface varies from gently undulating to gently rolling. In general it is not as rolling as are the Miami soils, and only a very small part of the type is excessively rough or broken. In the town of Claybanks high bluffs rise a short distance back from the lake shore. The natural drainage of the type is good except in depressions or along the borders of marshes or of low-lying soils like the Superior and Poygan. In such places tile drains could be profitably installed. On the tops of some of the knolls and hills the surface soil has been washed away, leaving the subsoil exposed. Such spots, however, are rare, and erosion is not serious.

The Kewaunee loam has originated partly from lacustrine and partly from glacial material. The red clay was deposited in the quiet waters of a lake before the Glacial Period. The glacier mixed this clay with gravel, bowlders, and rock fragments, and left the surface undulating and broken. The underlying limestone was broken and crushed, giving rise to the fragments which now are scattered through the soil and subsoil. Through the long inter-

vening period of weathering the lime has been leached from the surface material, so that it is now usually in an acid condition.

The original timber growth on this type consisted of both pine and hardwoods. In some sections white pine predominated, in other areas hardwoods alone grew, while in still others hemlock, pine, and hardwoods formed a mixed growth. The principal hardwoods were maple, birch, basswood, beach, elm, and some oak and hickory. All the valuable timber was removed long ago, and in many places a second growth of birch and poplar has sprung up.

The Kewaunee loam is highly improved, and the greater part of it is under cultivation. Some of the largest and most up-to-date farms in the county are on this soil. General farming, with dairying as the principal side line, is carried on. The most important crops produced are oats, peas, barley, rye, corn, timothy, clover, and potatoes. On most farms the chief source of income is dairying, which is rapidly becoming more important. Many pure-bred herds, principally Holstein and Guernsey, are kept. The soil produces excellent yields of hay, while corn, although it does not always mature, never fails to reach the stage where it can be used for silage. Many farms are now equipped with silos, more of which are being constructed yearly. In the vicinity of Sawyer some peas are grown for canning, and in areas near the water cherries and apples are grown. The type, however, is not as well adapted to the growing of fruit as are the Miami soils. Oats are grown more extensively than any other grain. Yields ordinarily range from 30 to 50 bushels per acre. Barley yields 20 to 35 bushels, rye 15 to 20 bushels, and potatoes 125 to 200 bushels. Timothy and clover produce heavy crops.

Land of this type sells for \$75 to \$125 an acre, depending on the location and improvements.

This soil works up readily and is on the whole quite easily handled, in spite of the heavy subsoil. Fall plowing is practiced almost exclusively. In some of the more nearly level areas some system of artificial drainage should be installed. Stable manure is the only fertilizer used to any extent. Often the crop rotation followed is not the one best suited to conditions. The organic content of this type is low. It can be increased by supplementing the barnyard manure with green-manure crops. Clover should be plowed under every fourth year. The type is benefited by phosphatic fertilizers. If rock phosphate is used the first application should be at the rate of 400 to 600 pounds per acre, to be followed by about half this amount every fourth or fifth year. A good crop rotation for this soil is as follows: The first year a small grain, seeded to clover and a little timothy; second year, clover; third year, mixed timothy and clover; and fourth year corn or potatoes.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of the Kewaunee loam:

Mechanical analyses of Kewaunee loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
312517.....	Soil.....	1.0	3.6	4.5	20.8	23.1	37.6	8.9
312518.....	Subsoil.....	.7	3.7	5.2	22.8	19.1	30.2	18.5

KEWAUNEE CLAY LOAM.

The Kewaunee clay loam to an average depth of 8 inches consists of a reddish-brown clay loam which contains a high percentage of silt and is low in organic matter. Gravel, stones, and bowlders are scattered over the surface in places. The subsoil consists of a heavy, compact, red clay loam, which extends to the underlying limestone rock. In the subsoil, especially just above the bedrock, angular gravel, bowlders, and small fragments of limestone are encountered, but the gravel is not as abundant as in the Kewaunee loam. A small percentage of the gravel and bowlders is of rocks foreign to the region, such as granite, quartz, and gneiss.

The depth and color of the surface soil vary somewhat. In depressions and on gentle slopes the soil is deeper and darker than typical, while on hills and knolls the red clay subsoil is frequently exposed. The depth to bedrock also varies. In some places the depth is less than 3 feet and elsewhere it may be 15 feet or more. In sections 4, 5, 8, 17, and 24, of Gardner Town, and on the plateau-like formation in sections 21, 22, 28, and 29, Brussels Town, the depth to the underlying rock is less than typical, being in many places less than 3 feet. A number of outcrops also occur in these sections. In sections 22, 23, and 26, in the town of Brussels, the surface is less rolling than typical, but the soil is hardly sufficiently level to be included with the Superior soil.

Next to the Kewaunee loam this is the most extensive and important soil in the southern part of the county. It occurs only to the south of Sturgeon Bay. The surface varies from undulating to gently rolling, and in a few places to very rolling. The area surrounded by the rock escarpment in sections 20, 21, 28, and 29, Brussels Town, is elevated considerably above the surrounding country and presents a plateaulike appearance. The surface here is more nearly level than is typical. The type is more poorly drained than the Kewaunee loam and tile drains can profitably be installed especially where the surface is nearly level or where depressions occur.

The original timber growth on the Kewaunee clay loam consisted chiefly of birch, maple, beech, basswood, hemlock, balsam, and pine. Practically all the original timber has been removed.

This soil was originally laid down in a lake bed and later reworked by the glaciers. Some of the underlying Niagara limestone was broken up and mixed with the soil, and the surface features changed from level to undulating or rolling. The lime content increases with depth. In some places leaching has left the surface material in an acid condition.

The Kewaunee clay loam is naturally very productive and the greater part of the type is under cultivation. The chief crops grown are oats, wheat, rye, barley, corn, potatoes, clover, and timothy. Excellent yields of hay are obtained and the other crops produce well. Some new varieties of corn mature, but corn does not always ripen. It can always be depended upon, however, to reach the stage where it makes good silage. Dairying is the most important line of farming followed. The soil is ideal for growing hay and for maintaining good pasture. In general it gives practically the same yields as the Kewaunee loam.

The drainage is inadequate over a considerable proportion of this soil. Much of the land is wet in the spring, and early cultivation is difficult. The low, wet spots and areas which have but little slope could be profitably drained by installing tile. There is danger of puddling and lumping if the soil is plowed or cultivated when too wet.

A definite crop rotation should be followed on this soil. Good results have been obtained from the following rotation: First year a small grain, seeded to clover and timothy; second year clover, the first crop cut and the second crop plowed under to increase the supply of organic matter; third year a cultivated crop, such as corn or potatoes. When there is a good supply of organic matter the rotation may be lengthened. Barnyard manure, which is almost the only fertilizer used, can be applied either on the sod or after the plowing. Applications of phosphate fertilizers have resulted in marked increases in crop yields.

This soil is more difficult to handle than most of the soils of Door County. It should never be worked immediately after a heavy rain. The organic-matter content should be increased by green manuring.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Kewaunee clay loam:

Mechanical analyses of Kewaunee clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
312515.....	Soil.....	0.5	3.3	4.4	20.0	11.4	35.3	25.2
312516.....	Subsoil.....	1.0	3.5	4.7	19.9	14.0	29.5	27.4

SUPERIOR CLAY LOAM.

The typical Superior clay loam to a depth of 6 or 8 inches consists of a dark-brown to reddish-brown clay loam. In places the surface soil is gray. The subsoil is a heavy, compact, red clay, extending to depths below 3 feet. Occasionally a little gravel occurs on the surface, and there is usually some gravel in the subsoil. Very few stones occur in this type.

Some variations occur in color and texture. In the area just south of Brussels and in section 25 of Union Town the surface soil is darker than typical, but not dark enough to be typical of the Poygan loam. Near the edges of marshes and bordering soils of the Poygan or Clyde series the surface soil is usually dark colored. In some places the surface soil is more nearly a loam than a clay loam. The red clay is seldom exposed at the surface.

The Superior clay loam covers only about 5 square miles. The largest area occurs just south of Brussels. Smaller areas are scattered throughout the southern part of the county, occupying depressions and level situations within the large bodies of Kewaunee soils. Owing to the level to very gently undulating surface and heavy texture, the drainage of this soil is very deficient. In many places, especially in depressions, water stands until late in the spring and after heavy rains at other seasons of the year.

The Superior clay loam has practically the same origin as the Kewaunee soils, but the material has been modified by glacial action to a much less extent. The originally level surface was only slightly changed by the passing glacier, and little gravel and few fragments of limestone were mixed with the soil.

A considerable proportion of this type is under cultivation. Part of it still supports the original forest, and some areas are covered with a second growth of poplar. The original timber growth was largely maple, beech, birch, elm, and white pine. The chief crops grown are oats, barley, rye, corn, clover, and timothy. In wet seasons crops often produce very poor yields. In ordinary years the yields of the general farm crops are about the same as on the Kewaunee soils. The yield of hay is especially good.

The Superior clay loam, the most difficult soil in the county to handle, requires very thorough tillage to maintain a satisfactory seed bed. When plowed too wet it is apt to puddle, and in the heavier areas large clods are frequently turned up. The type, especially in the low, wet spots, remains wet and soggy until late in the spring. Stable manure is the only fertilizer used.

The foremost need of this soil is better drainage. Tile drains could be profitably installed, as has been proved on similar soils in other sections of the State. With thorough drainage the land could be

worked earlier in the spring, cultivation could be done more easily and thoroughly, and larger yields would be obtained. Fall plowing should be practiced whenever possible. Green manures should be used to increase the supply of organic matter.

POYGAN LOAM.

The Poygan loam, to a depth of 8 to 10 inches, consists of a heavy, black loam, high in silt. The subsoil is a heavy, red clay, similar to that of the Superior series, but below 24 inches the red clay is usually mixed with fragments of partially decomposed limestone. Bedrock is sometimes encountered within 3 feet of the surface.

The type is very inextensive and of little importance agriculturally. It occurs in small areas varying in size from 20 to 200 acres, and is confined to the southern part of the county. Small tracts are scattered throughout the main body of the Kewaunee soils, occupying depressions or low areas along streams and marshes. The largest single area is mapped in section 27, Brussels Town.

The Poygan loam has a level surface, and on account of its low, swampy position and heavy, tenacious subsoil the drainage is very deficient. In some areas water stands on the surface a large part of the year.

The type is largely of lacustrine origin, but has probably been influenced slightly by glacial action. The decay and accumulation of a dense growth of vegetation through long periods has resulted in the dark color and high content of organic matter. The surface soil is acid, but the subsoil ordinarily is neutral or calcareous.

Only a very small percentage of the Poygan loam is under cultivation. Much of it remains just as it was left after the timber was removed. The forest growth consists of cedar, ash, elm, birch, and hemlock, with a second growth of poplar in some areas. In other sections of the State similar soils have been drained and made to produce good yields of the common crops. The type is well adapted to the growing of grasses. It is heavy and quite difficult to handle and before it can be worked successfully and made to produce profitable yields it must be thoroughly drained. Tile drains should be installed throughout the type. Care must be taken to plow and cultivate only when the moisture content is right. When worked too wet the soil puddles and on drying cracks up into hard clods, which are very difficult to pulverize. Unlike most of the soils of Door County, this type has a good supply of organic matter.

CLYDE LOAM.

The Clyde loam consists of about 12 inches of black, mellow loam containing considerable silt and organic matter, underlain by a subsoil of grayish fine sandy loam which becomes lighter colored and

lighter in texture with depth. The deep subsoil is reddish in color, heavy, and compact.

The type is subject to some variation. In depressions there may be a thin layer of peat on the surface. In places 5 or 6 inches of fine sand may be encountered immediately underlying the surface soil. The texture of the subsoil may vary from a fine sandy loam to a clay loam. The depth to bedrock ranges from 2 feet to several feet.

A lighter textured soil is included with this type on account of its small extent. To an average depth of 8 inches it consists of a very dark colored fine sandy loam, underlain by a grayish fine sandy loam which becomes lighter colored with depth. In all other respects it is similar to the Clyde loam.

The Clyde loam occurs in all parts of the county, but mostly in the area of Miami soils. It occupies depressions between hills, or along streams or at the borders of Peat marshes. The size of the areas varies from 10 to about 100 acres. Owing to the level surface and low position the natural drainage is poor. The water table is within a few feet of the surface and during heavy rains in the spring and early summer water stands on the surface for a long time.

The surface soil of this type is slightly acid in places, owing, it is thought, to acids formed by the decay of organic matter in addition to the leaching out of lime from the soil.

A large part of the Clyde loam is still unimproved. In its present undrained condition it can be used only for pasture. Much of it is too wet and too thickly covered with brush to be used even for this purpose. The timber growth consists of elm, ash, willow, and cedar, with some birch and alder and other water-loving trees.

Where thoroughly drained this soil is well suited to nearly all the common farm crops, and especially to grasses. The virgin soil is high in organic matter. In other parts of the State similar soils when improved have given excellent yields, returning the cost of drainage in a comparatively short time.

CLYDE SILT LOAM.

The Clyde silt loam, to a depth of 8 to 12 inches, consists of a very dark colored silt loam. This is underlain by a subsoil of heavy, slightly mottled, bluish silt loam or clay loam. The lower depths contain considerable limestone fragments and gravel.

Variations occur in texture, color, and depth to bedrock. In some depressions a shallow layer of peat may occur on the surface, while in other spots the surface soil may approach a loam in texture. In some places the subsoil may be sandy. The depth to bedrock varies, the minimum being about 2 feet.

The Clyde silt loam occupies swampy depressions in the upland or along streams. The areas, which occur in all parts of the county,

vary in extent from 10 to about 100 acres. The surface is level, and owing to its low position and heavy subsoil the soil is wet and soggy.

The type is of both glacial and waterlaid origin. Large accumulations and decay of organic matter in the presence of moisture have resulted in the high content of organic matter and the dark color.

Only a small part of this type has been cleared and most of this is used for pasture. The original forest growth consisted of elm, ash, cedar, birch, and willow. The principal need of the type is better drainage. Most of it can be drained and made into good land, as it is inherently productive. In other parts of the State similar soils when drained produce good yields of corn, cabbage, hay, and various other crops.

FOX SILT LOAM.

The Fox silt loam to an average depth of 8 inches consists of a grayish to dark-brown, friable silt loam, which has a smooth feel when moist and assumes an ashen-gray appearance when dry and pulverized. The subsoil consists of a gray or yellowish-brown loam or fine sandy loam. The deep subsoil is often sticky and sometimes consists of a light-colored marllike material. The limestone bedrock usually is encountered within 3 or 4 feet of the surface. The soil is usually neutral or calcareous.

This type is of very small extent. Small areas occur near Sturgeon Bay and elsewhere in the northern part of the peninsula. The type is confined to the region of Miami soils. Its surface is level to very gently undulating, and the natural drainage is usually poor.

The Fox silt loam occurs on outwash plains, in filled-in valleys, or on lake or stream terraces, and consists of material deposited by water, chiefly by streams issuing from the glacier. The soil has been formed from glacial debris ground mainly from the limestone underlying this part of the State.

The original forest growth on this soil consisted chiefly of elm, ash, birch, and maple, with willow in the lower situations. Some areas are under cultivation, and where drainage conditions are favorable the yields average about the same as on the Miami silt loam and loam. Corn, oats, barley, and hay do well. This soil usually forms parts of fields in which the Miami loam is the predominating type, and the methods of cultivation, crop rotation, and fertilization are practically the same as on the latter soil.

Some small areas of a fine sandy loam are included with the Fox silt loam. This coarser soil consists of an average of 8 inches of friable, dark-brown fine sandy loam, with a subsoil of light-colored fine sandy loam which becomes lighter in texture with depth. The deep subsoil is usually a pale-yellow very fine sand. In some places a sticky layer of sandy clay may occur at about 2 feet, but

this layer is usually underlain by sand. This coarser soil occupies a total area of less than 1 square mile. The largest area occurs on Washington Island, in the vicinity of Detroit Harbor. A few small patches occur in other parts of the county, all north of Sturgeon Bay. The surface is level, but the drainage is fairly good, on account of the sandy subsoil. The soil is derived from the weathering of glacial outwash-plain material, and contains considerable limestone gravel. It differs from the Plainfield soils in that it has been derived largely from limestone, while the Plainfield soils have been derived largely from sandstone. A considerable part of this fine sandy loam soil is under cultivation. It produces good yields of the common crops. It can be easily worked into good tilth.

PLAINFIELD SAND.

The Plainfield sand consists of a light-brown, loose sand to a depth of 8 to 10 inches. The subsoil is a light-colored sand which assumes a marked yellowish tinge in the lower depths. The little gravel that occurs consists mainly of chert, quartz, or quartzite. The soil is very uniform throughout its development.

This type is confined to Chambers Island in Green Bay and a small area south of Clark Lake in Sevastopol Town. Chambers Island, which has an area of about 4 square miles, is occupied almost entirely by Plainfield sand.

The surface of this type is level to gently undulating. It was originally more nearly level than at present, wind and other agencies having changed the topography slightly. The soil is very easily affected by drought, and crops suffer from lack of water during at least a part of nearly every season.

Only a very small total area of the Plainfield sand is cleared and under cultivation. The original timber growth consisted largely of white pine, with various kinds of oak, maple, and other hardwoods in varying amounts. On Chambers Island a thrifty growth of young timber, mainly pine, is springing up. The principal use of the type here is for a game preserve and for summer homes.

In wet years when manured heavily this soil has given fairly good yields of different crops. Corn, potatoes, rye, buckwheat, and truck crops are well adapted to the Plainfield sand.

PLAINFIELD FINE SAND.

The surface soil of the Plainfield fine sand is a light-brown to dark-brown fine sand or loamy fine sand, about 8 inches deep. The subsoil is a lighter colored fine sand, with a marked yellow tinge in the lower depths. Red clay is usually encountered at 3 to 6 feet below the surface. In the area at the foot of the bluffs along the lake shore

in Claybanks Town the surface soil is quite dark colored, being nearly black in places, while the area along the shore in Union Town has a light-brown or even yellow surface soil. In Union Town, too, the heavy subsoil is closer to the surface than in Claybanks Town.

The Plainfield fine sand covers less than 2 square miles and is one of the least important types in the county. It is confined to two areas, one on each side of the peninsula. One area occupies a narrow terrace lying between the foot of the high bluffs and the Lake Michigan shore in Claybanks Town; the other occurs along the Green Bay shore in sections 28, 21, and 16, Union Town.

The surface of the type is level to slightly undulating, and it lies only 5 to 15 feet above the level of the lake, but the natural drainage is good except at the foot of the bluffs, where seepage from the highland keeps the soil wet.

This soil has been brought to its present position by the action of water. The terrace on the Lake Michigan side was probably formed when the water level was higher than it is now, the sand in both areas being undoubtedly Beach sand. The red clay subsoil which underlies the sand is also waterlaid.

Only a small proportion of the Plainfield fine sand is under cultivation. The original timber growth consisted of scrub oak, mixed hardwoods, and some white pine and hemlock. The yields of the common farm crops are lower than on the heavier soils, but such crops as potatoes, strawberries, and truck do very well.

The area in Union Town is low in organic matter. Stable manure, which is the only fertilizer used, should be supplemented by green manuring. The soil is well adapted to the growing of truck, and trucking could well be more highly developed. The acid condition of the soil should be corrected by applying lime at the rate of about 1 ton per acre.

PEAT.

Peat includes several kinds of swamp and marsh land the soil of which consists chiefly of roots, grasses, sedges, leaves, moss, and other organic matter in various stages of decomposition. There is usually incorporated a small amount of mineral matter. The soil is dark brown to black in color and 8 inches to several feet in depth, being shallow at the border of the marsh and deeper near the center. In some of the marshes the subsoil consists of extensive deposits of marl.

There are approximately 60 square miles of Peat in Door County. A little more than half the type occurs in that part of the county south of Sturgeon Bay. The largest area is mapped near the east shore of the peninsula in the northern part of the county, extending from a point just north of North Bay to Bailey Harbor. Between

the shore and the swamp there is a narrow strip of high land. The points projecting into North Bay, Mud Bay, and Bailey Harbor are extremely rocky. This marsh covers about 13 square miles. Another large marsh extends from a point about 3 miles south of the Sturgeon Bay ship canal to Clark Lake, reaching one-half mile to about $1\frac{1}{2}$ miles inland. Like all the large marshes along the Lake Michigan shore it is separated from the lake by narrow strips of high land, mainly beach sand. To the north of Sturgeon Bay the western part of the county is practically free from peat marshes; the only two of importance are the one extending southeast from Ephraim and the one extending southeast from Ellison Bay. In the region of the Kewaunee soils to the south of Sturgeon Bay there are numerous areas of Peat of various sizes. The largest is the one in sections 20, 21, 22, 26, and 28, Gardner Town. Other areas of over 1 square mile occur in Nasewaupée, Forestville, and Brussels Towns.

All the Peat lands are level and low lying. The drainage is poor, owing to the lack of drainage outlets or because of a heavy, impervious subsoil below the organic soil. In the southern part of the county the subsoil is heavy, but in the large areas along the lake shore north of Sturgeon Bay it is more sandy and porous. In these large areas there occur islands of sand which are not shown on the map.

Most of the Peat areas of Door County are wooded, the growth consisting of cedar, tamarack, ash, willow, and some elm and spruce. Where the Peat is deepest tamarack predominates, but along the border of the marshes or where the Peat is shallow ash, elm, and willow predominate. The largest open marsh in the county is the one extending from Ellison Bay to Rowley Bay.

Most of the Peat areas are wet the greater part of the year, and in the spring and during wet seasons water stands on the surface. The slope is nowhere sufficient to drain the excess water without open ditches or tile. The large marshes along the Lake Michigan shore do not lie very much above the level of the lake, and drainage here would be quite difficult. Very little of the Peat land has been reclaimed, although many areas could be drained and profitably cultivated. Many small marshes could be drained at comparatively low cost. Reclamation of the larger ones would require large expenditures and the organization of drainage districts.

MUCK.

Muck consists of vegetable matter in varying stages of decomposition, with which there are incorporated large amounts of mineral matter. It is more thoroughly decomposed than Peat, contains more mineral matter, and may be considered as intermediate between Peat

and the soils of the Clyde series. Practically all of the Muck is relatively shallow, and in some places the type as mapped consists of Peat underlain at 6 to 10 inches by silt loam or fine sandy loam. When plowed the soil here consists of a mixture of Peat and silt loam which has nearly the composition of true Muck.

Muck occurs only in small areas. These are scattered throughout the area, mainly along streams or at the border of areas of Peat. It occupies about the same topographic position as Peat, and is poorly drained and swampy. With drainage well established the soil is very productive, but in its present undrained condition it is only of value for the pasturage it affords and the marsh hay which is cut from some areas.

BEACH SAND.

The type mapped as Beach sand consists of a grayish fine or very fine sand which continues with little change throughout the 3-foot section, except that the subsoil has a marked pale-yellowish tinge. There is little or no organic matter in the soil.

This type is confined largely to a narrow strip bordering Lake Michigan from a point a short distance south of the Sturgeon Bay ship canal to the north end of the peninsula. It varies in width from three-fourths to less than one-fourth mile, but is not continuous along the entire east side of the county. The widest and most typical area occurs at Jacksonport. Some small areas are mapped on Washington Island.

The surface of this soil varies from undulating to very rolling or bumpy, being typically quite rolling. Drainage is excessive, and crops suffer from lack of water except in very wet seasons.

Beach sand consists of material washed onto the shore by the waves. Much of it has been drifted by the wind, forming the broken, bumpy surface, and a considerable proportion consists of shifting sand dunes.

On account of its low productiveness and other unfavorable features only a small part of this soil is under cultivation. The timber consists mainly of pine and oak, neither of which grow very large or dense. The type is not likely to be farmed extensively for some time. Rye, oats, corn, and potatoes, are grown, but the yields are low except very near the shore, where the water of the lake is but little below the surface of the land.

The system of farming on this soil should be such as to increase its content of organic matter and its water-holding capacity. Stable manure should be supplemented by green-manure crops, the soil should be limed, and commercial fertilizers used. Great care should be taken to guard against wind erosion. The type is better adapted to the production of truck crops than to general farming, but owing

to the long distance to market the trucking industry has not been developed.

Some small areas of gravel are included with the Beach sand as mapped. The soil in such areas consists of about 4 inches of gravelly sandy loam underlain by beds of gravel and sand. It occurs in very narrow strips along the shore, largely on the Green Bay side of the peninsula, and is of little importance. The point of land extending into the bay at Fish Creek is largely occupied by this soil. Another small area occurs along the shore in sec. 34, Sturgeon Bay Town, and in sec. 3, Claybanks Town. The surface is level to undulating. The soil represents a beach formation consisting of material washed up on the shore by the waves. No effort has been made to grow crops on this soil, and it may be classed as nonagricultural.

ROUGH STONY LAND.

Rough stony land includes areas so rough, broken, or rocky as to be of little or no value for farming. It occurs largely in long, narrow strips in the form of high bluffs, slopes, or steep cliffs. It is practically all confined to the west side of the peninsula, where it occurs either on the shore or a short distance back from the shore, and represents either the present or a previous shore line. The longest area of Rough stony land extends from a point about 5 miles northwest of the city of Sturgeon Bay to a point about 3 miles north of the village of Egg Harbor. The type includes the bluffs at Fish Creek, Ephraim, Sister Bay, and Ellison Bay, and those in the State Park. On the point of land between North Bay and Mud Bay the type is much more nearly level than typical, but the extensive rock outcrops, the stoniness, and the extremely shallow soil render the land practically valueless for agriculture. On the slopes and cliffs extensive outcrops of limestone occur.

The timber growth on the Rough stony land consists of maple, birch, balsam, pine, and poplar. The best of the timber has been removed, but considerable remains and should be left to protect the slopes from washing.

Over some of the slopes there is only a shallow covering of soil, while some areas are well covered. The soil varies from fine sandy loam to loam. No attempts have been made to cultivate this land, but it may furnish some pasturage.

SUMMARY.

Door County is situated in the eastern part of Wisconsin, on Lake Michigan. It lies within the glaciated-limestone region and its surface varies from undulating to gently rolling. Over much of its area the soils are shallow and quite stony. Its total area, including

Washington and Chambers Islands, is 469 square miles or 300,160 acres.

The first permanent settlements in Door County were made about 1852. The county was originally heavily wooded, and for a long period lumbering was the chief industry. Nearly all the desirable land in the county is now in farms, and much of the soil is under cultivation.

The population, 1910, was 18,711. Sturgeon Bay, the county seat, had, in that year, a population of 4,262.

There are only about 15 miles of railroad in the county, but good wagon roads and automobile stage lines reach all sections.

The climate of Door County is favorable for general farming, dairying, and fruit growing. The mean annual temperature is about 43° F., the mean annual precipitation about 31 inches, and the average length of the growing season about 129 days. The waters of Green Bay and Lake Michigan stabilize frost occurrence and make conditions ideal, in this respect, for fruit growing.

The agriculture of Door County embraces fruit growing, dairying, and the production of general fruit, canning, and truck crops. The cherry is the fruit most extensively produced. The climate and soil are apparently ideal for this fruit, and over 3,500 acres have been set in orchards. The apple also thrives.

The Late Wisconsin drift is the surface formation covering Door County. The bedrock is Niagara limestone. The red clay extensively developed in the southern part of the county is of lacustrine origin, but since its deposition it has been modified more or less by glacial action.

Excluding Rough stony land, Peat, Muck, and Beach sand, 7 soil series are recognized in the county.

The Miami series consists of light-colored, timbered upland soils derived from glacial limestone material. This is the most extensive and important series in the county. The loam is the predominating type, and it is on this soil that most of the cherries are grown. The silt loam is well adapted to general farming, and dairying is becoming an important industry.

The Kewaunee series is derived from both lake-laid and ice-laid material, and is characterized by having heavy, red clay in either the surface soil or subsoil. The loam is the predominating type, but there is also a considerable acreage of the clay loam. The soils of this series make excellent general-farming land, well adapted to dairying.

The Superior series is similar to the Kewaunee, except that the surface is nearly level, while the Kewaunee soils are rolling. The clay loam, the only type mapped, is low, wet, and poorly drained.

The Poygan loam is closely associated with the Kewaunee and Superior soils and is of the same origin, but it has a black surface soil with a red clay subsoil. It occupies low, wet, and poorly drained areas where there has been a large accumulation of organic matter.

The Clyde series consists of black soils of alluvial or lacustrine origin occupying old lake beds, ponded valleys, or first-bottom areas along the streams. These soils are low and poorly drained, but they are very productive and give good yields when drained and improved.

The Fox series includes light-colored soils in glaciated-limestone regions, occupying outwash plains or stream terraces. The series is not very extensive in this county.

The Plainfield sand and fine sand are of small extent and of little importance. They are light-colored soils of alluvial origin, derived largely from sandstone formations. They are loose and open, and droughty during at least a part of each growing season.

Peat occurs in numerous areas of varying size in different parts of the county. It consists of vegetable matter in various stages of decomposition, with small amounts of mineral matter. At present most of this land is wet and undrained and of no agricultural use whatever, but much of it can be drained and made into valuable land.

Muck includes highly organic soils intermediate between Peat and the Clyde soils. It is not very extensive in Door County.

Beach sand consists of material which has been washed on shore by the waves and blown by the wind so as to have a broken, bumpy topography. Much of it is shifting sand dunes, and it is of little value.

Rough stony land comprises steep, rocky slopes or rock outcrops where the land is too broken or the soil too shallow and stony for cultivation.



[PUBLIC RESOLUTION—No. 9.]

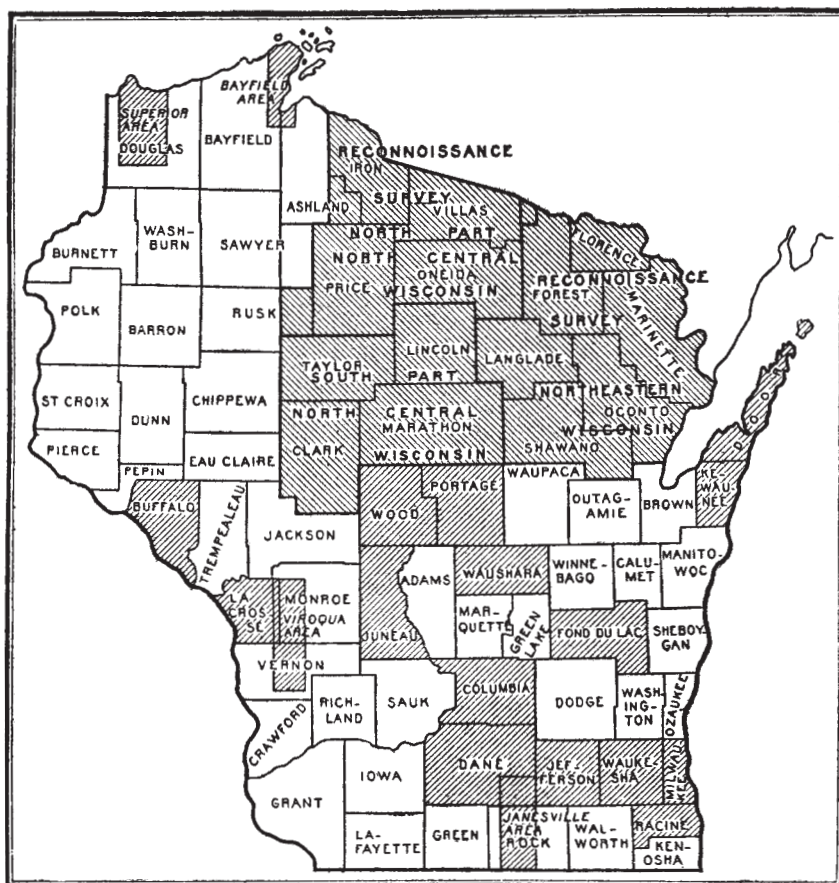
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Wisconsin.

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